76001

Drive Tube

Station 6

Figure 1: Low-resolution scan of epoxy encapsulated core 76001(about 30 cm long).

high-res

Introduction

Lunar core 76001 (~34.5 cm) was collected from the bottom of the slope of the North Massif about 250 meters for the boundary with the mare surface and about 10 meters below the big boulder seen in all the pictures. It is a single drive tube (711.6 grams).

To date, drive tube 76001 has not been analyzed in as much detail as other lunar cores. It was found to be relatively uniform with depth, apparently due to continuous downslope migration of material from the North Massif (Korotev and Bishop 1993). The depositional history of this core is discussed by Nishiizumi et al. (1990) based on data for cosmogenic radionuclides.

Petrography

Stu Nagle (1979) first described core sample 76001 and Papike and Wyszynski (1980) reported the optical mineral mode. While Nagle could distinguish as many as six stratigraphic units based on bulk observation, Papike and Wyszynski could only distinguish two petrographic units using thin sections; B (top) and A (bottom). Unit B extends from 0-20 cm, while unit A extends from 20-32 cm. Unit B is enriched in KREEPy noritic breccia and depleted in gabbroic anorthosite reative to unit A. Basalt fragments and fragments of the orange glass are present throughout the core, but only appear to be a minor component. This is surprising considering that the core was taken not far from a Mare surface and that the whole area is seen form orbit to have a “dark mantle”.

Mineralogical Mode 76001

a la Papike and Wyszinski (1980)

	Unit A	Unit B
Mare Basalt	2.6 %	3.8
Anor. Norite, Troct.	13.5	5.1
RNB + POIK	4.4	8.4
Fused Soil	43.2	48.6
Oliv. + Pyx.	4.9	5.7
Plagioclase	24.4	22
Opaque	1.2	1.3
Orange glass	2.9	3.2
Other glass	2.9	1.9

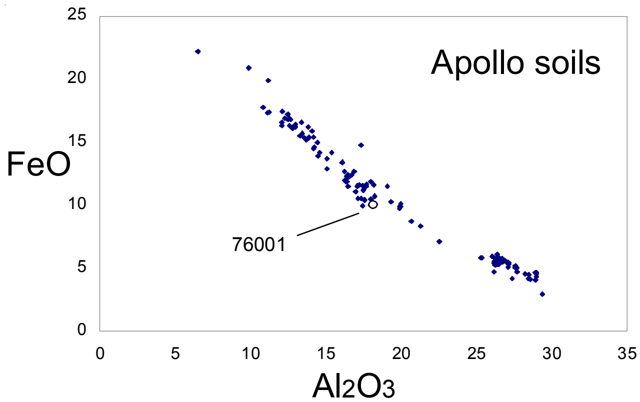

Figure 2: Chemical composition of lunar soils campared with that of 76001.

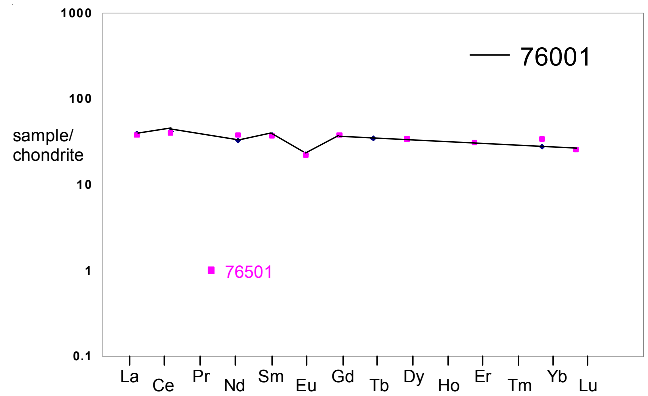

Figure 3: Normalized rare-earth-element composition of 76001 compared with that of 76501 (from Korotev, unpublished and Hubbard et al. 1974).

Morris and Lauer (1979) found that the magnetic maturity index (Is/FeO) was uniformly mature with depth (figure 4).

Chemistry

Korotev and Bishop (1993) found that 76001 had a relatively homogeneous chemical composition (62 splits) (with the exception of a few metallic iron nuggets with high Ir, Au or Ni). Table 1 compares the average composition of 76001 with that of 76501 and other soils at station 6 (Rhodes et al. 1974; Korotev and Kremser 1992). Average for the top of the core (unit B) and for that of the bottom (unit A) show that they are basically the same mix of highland materials and mare materials (~3 to 1). Interestingly soil samples found near the big boulder have slightly elevated REE – probably derived from the boulder.

One might speculate that the slight increase in trace element content of unit B compared to that of unit A was due to the arrival of the big boulder about 20 m.y. ago !

Cosmogenic isotopes and exposure ages

The activity of cosmic and solar ray (SCR)-produced radionuclides has been carefully determined for core 76001. These include ^{22}Na, ^{26}Al and ^{53}Mn (figure 5) and ^{14}C, ^{36}Cl (figure 6). They generally show a predictable pattern for a core in steady state.

Other Studies

Crozaz (1980) found a high count of cosmic ray induced tracks throughout the core (figure 7).

Processing

Lunar core 76001 is a single drive tube collected from the soil at the bottom of the North Massif about 250 meters from the mare boundary. It was simply pushed in, up to about 16 cm, and then hammered (5-6 blows) to 37.1 cm (34.5 cm were recovered). 76001 was capped on both ends and brought to Earth in a bag where it was not well protected from spacecraft nor Pacific Ocean atmospheres.

In the LRL, it was X-rayed and material taken from the top 4 mm in order to have splits from the lunar surface (figure 8). It was then extruded and dissected in 1978 (Curatorial Newsletter#23). Finally, the remainder (~1/3) was encapsulated in epoxy, split lengthwise (twice), with one side cut into potted butts (PB) for three sets of continuous thin sections (as indicated). Figure 1 is a collage of photos of a sawn surface cut lengthwise thru the epoxy encapsulated core (called a "reference" piece).

Korotev and Bishop (1993) reported two kinds of contamination; high Au in the topmost samples and several "nuggets" of metallic iron (with terrestrial-like composition) in the upper part.

References

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Curatorial Newsletter (1979) Core synopsis 76001.

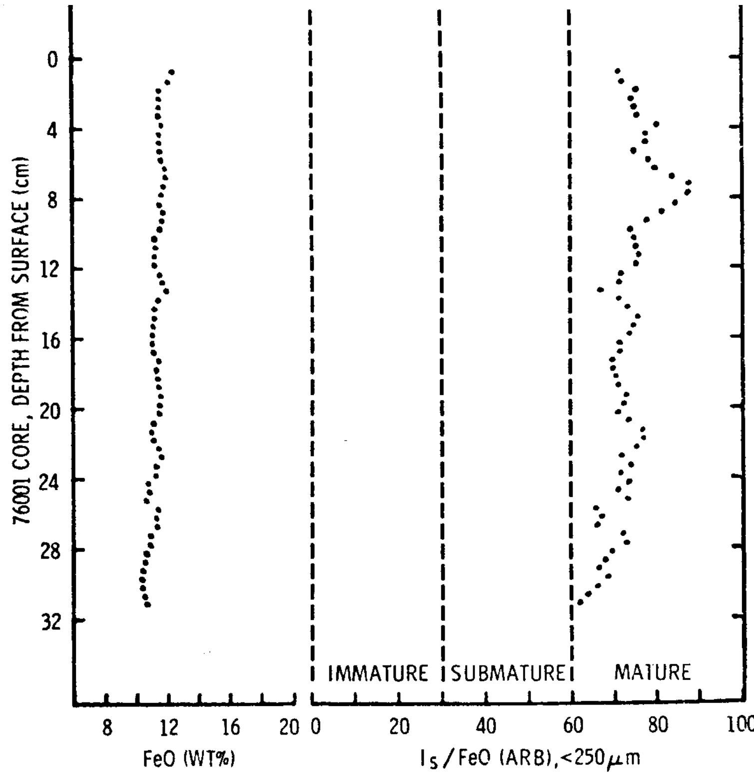

Figure 4: Morris and Lauer presented this depth profile of the FeO and maturity index of 76001 in their abstract (1979).

Evans J.C., Fruchter J.S., Reeves J.H., Rancitelli L.A. and Perkins R.W. (1980) Recent depositional history of Apollo 16 and 17 cores. Proc. 11th Lunar Planet. Sci. Conf. 1497-1509.

Jull A.J.T., Cloudt S., Donahue D.J., Sisterson J.M., Reedy R.C. and Masarik J. (1998) ^{14}C depth profiles in Apollo 15 and 17 cores and lunar rock 68815. Geochim. Cosmochim. Acta 62, 3025-3036.

Korotev R.L. and Bishop K.M. (1993) Composition of Apollo 17 core 76001. (abs) LPS **XXIV**, p. 819-820.

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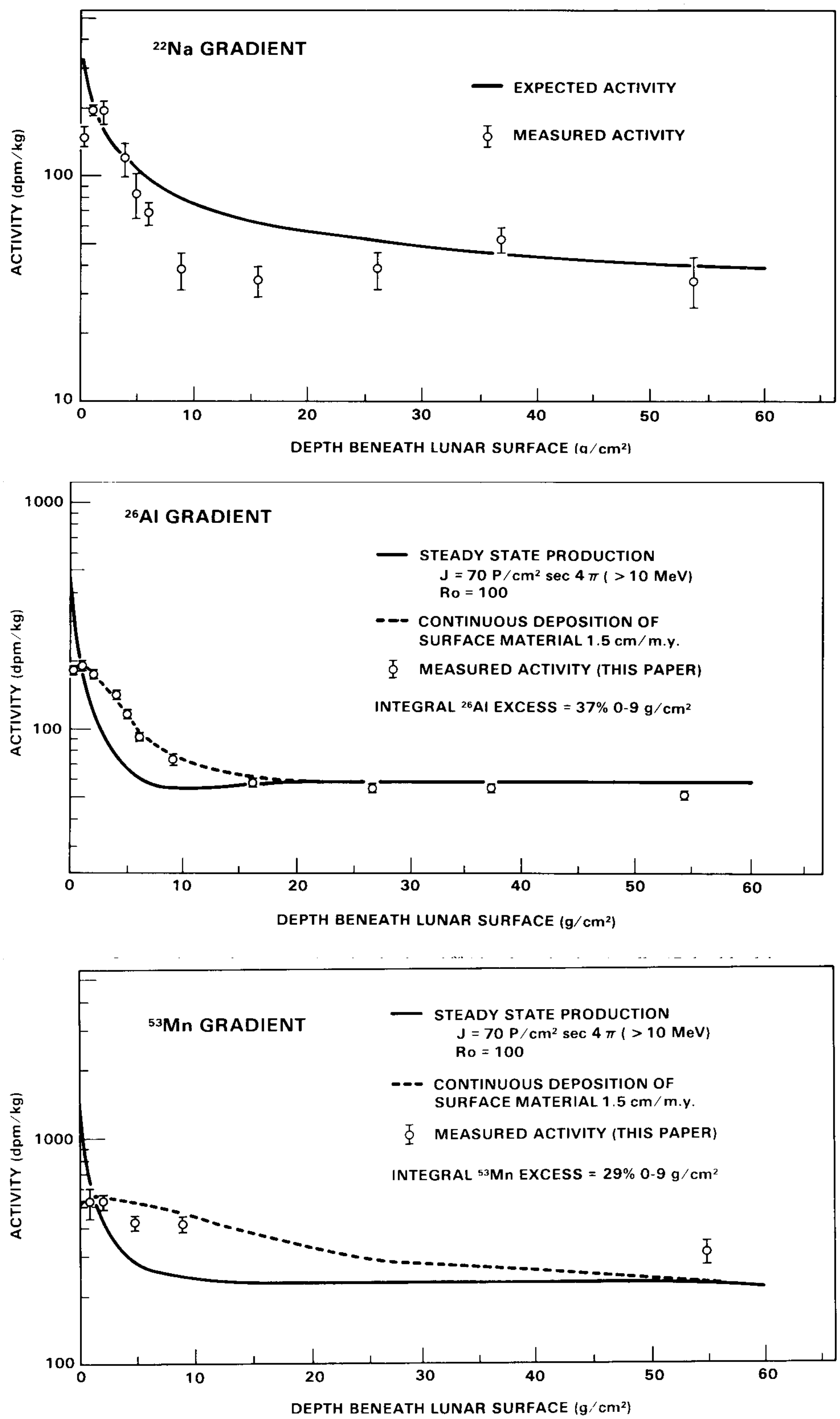
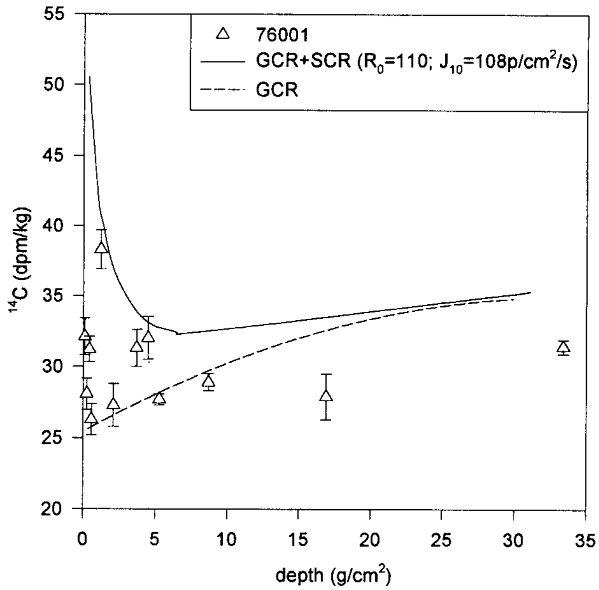


Figure 5 a, b, c: Cosmogenic radionuclides (22Na, 26Al and 53Mn) as a function of depth in 76001 (from Evans et al. 1980).



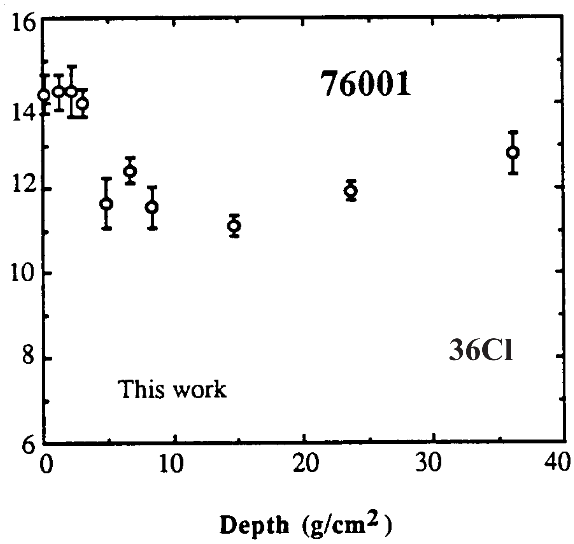


Figure 6 a, b: Depth profiles of radionuclides (14C and 36Cl) in lunar core 76001 (from Nishiizumi et al. 1990).

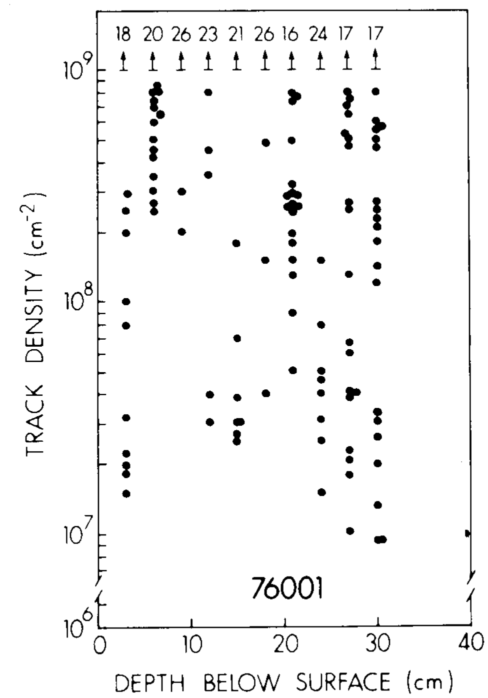


Figure 7: Crozaz (1980) tracks

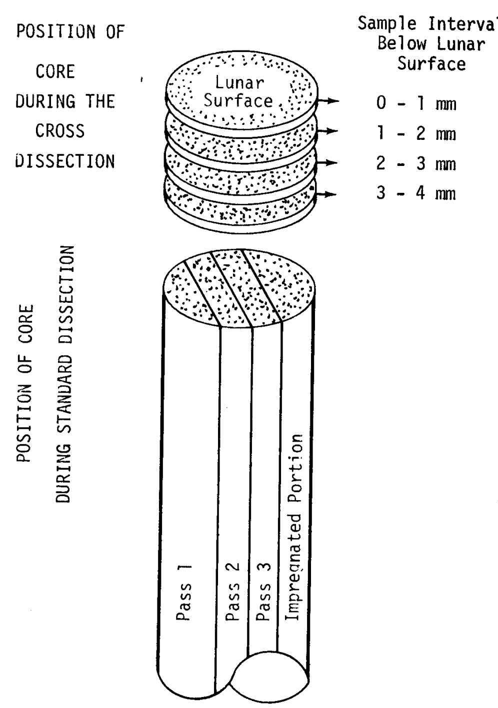


Figure 8: Illustration how the core was dissected.

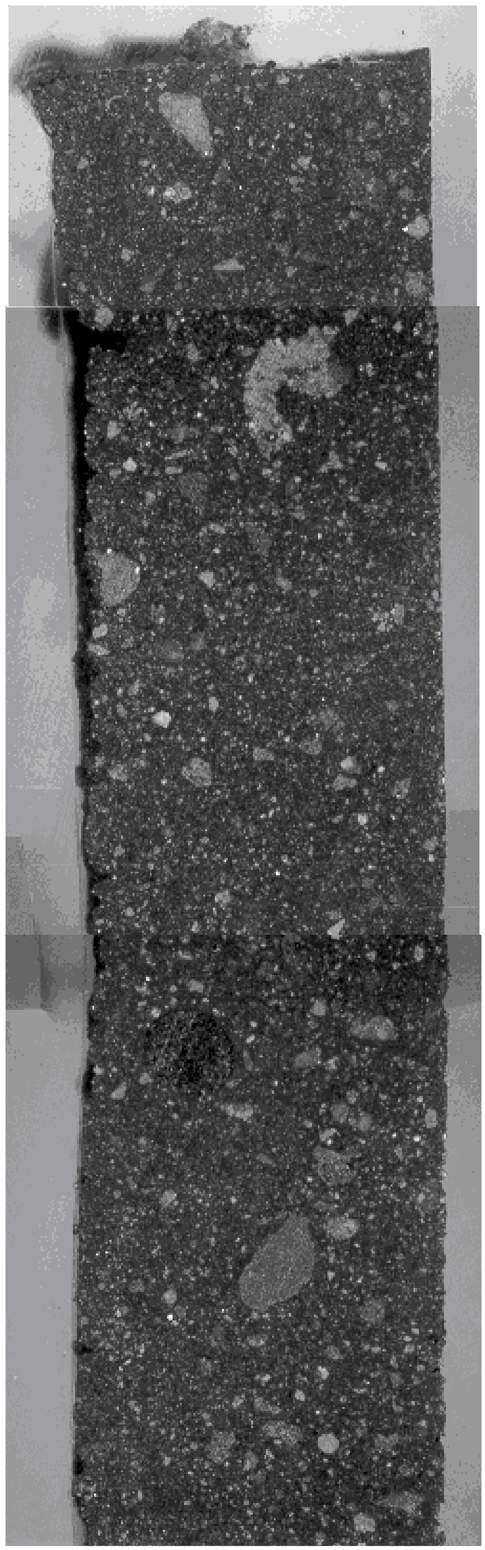
Table 1. Chemical composition of 76001 and station 6 soils.

reference	Korotev (unpublished)				Rhodes74		Korotev92	
weight	ave	unit B	unit A		76501		station 6	
SiO2 %					43.41	(c)	43.5	(d)
TiO2					3.15	(c)	3.35	(d)
Al2O3					18.63	(c)	18.25	(d)
FeO	10.58	10.6	10.3	(a)	10.32	(c)	10.73	(d)
MnO					0.14	(c)	0.15	(d)
MgO					11.08	(c)	10.76	(d)
CaO	12.3	12.3	12.2	(a)	12.28	(c)	12.15	(d)
Na2O	0.39	0.39	0.384	(a)	0.35	(c)	0.4	(d)
K2O					0.1	(c)	0.12	(d)
P2O5					0.08	(c)	0.095	(d)
S %					0.07	(c)	0.07	(d)
sum								
Sc ppm	28.2	28.7	27.5	(a)			28.8	(d)
V								
Cr	1887	1908	1855	(a)	1740	(b)	1920	(d)
Co	*37.6*	32.2	31.7	(a)			35.7	(d)
Ni	244	222	211	(a)	206	(c)	275	(d)
Cu								
Zn					29	(c)	28	(d)
Ga								
Ge ppb								
As								
Se								
Rb					2.4	(b)	2.7	(d)
Sr	154	155	148		151	(b)	155	(d)
Y					46	(c)	48	(d)
Zr	165	166	163		163	(b)	183	(d)
Nb					13	(c)	14	(d)
Mo								
Ru								
Rh								
Pd ppb								
Ag ppb								
Cd ppb								
In ppb								
Sn ppb								
Sb ppb								
Te ppb								
Cs ppm								
Ba	118	121	114	(a)	115	(b)	129	(d)
La	9.55	9.77	9.15	(a)	8.95	(b)	10.13	(d)
Ce	26.9	27.6	25.7	(a)	24.3	(b)	27.6	(d)
Pr								
Nd	17	18	15.5	(a)	17.4	(b)	19.7	(d)
Sm	5.9	6	5.7	(a)	5.55	(b)	6.21	(d)
Eu	1.29	1.3	1.27	(a)	1.25	(b)	1.33	(d)
Gd					7.51	(b)		
Tb	1.35	1.38	1.31	(a)			1.41	(d)
Dy					8.18	(b)		
Ho								
Er					4.89	(b)		
Tm								
Yb	4.81	4.9	4.64	(a)	4.53	(b)	5.02	(d)
Lu	0.673	0.68	0.65	(a)			0.7	(d)
Hf	4.83	4.87	4.75	(a)			5.01	(d)
Ta	0.75	0.76	0.72	(a)			0.76	(d)
W ppb								
Re ppb								
Os ppb								
Ir ppb	8.8	8.5	7.7	(a)			9.7	(d)
Pt ppb								
Au ppb	4.1	3	2.9	(a)			4.1	(d)
Th ppm	1.55	1.56	1.51	(a)			1.63	(d)
U ppm	0.42	0.42	0.42	(a)	0.44	(b)	0.44	(d)

technique: (a) INAA, (b) IDMS, (c) XRF, (d) literature average

Figure 9: Copies of polaroid photos of 76001 (scale indicated).

W1



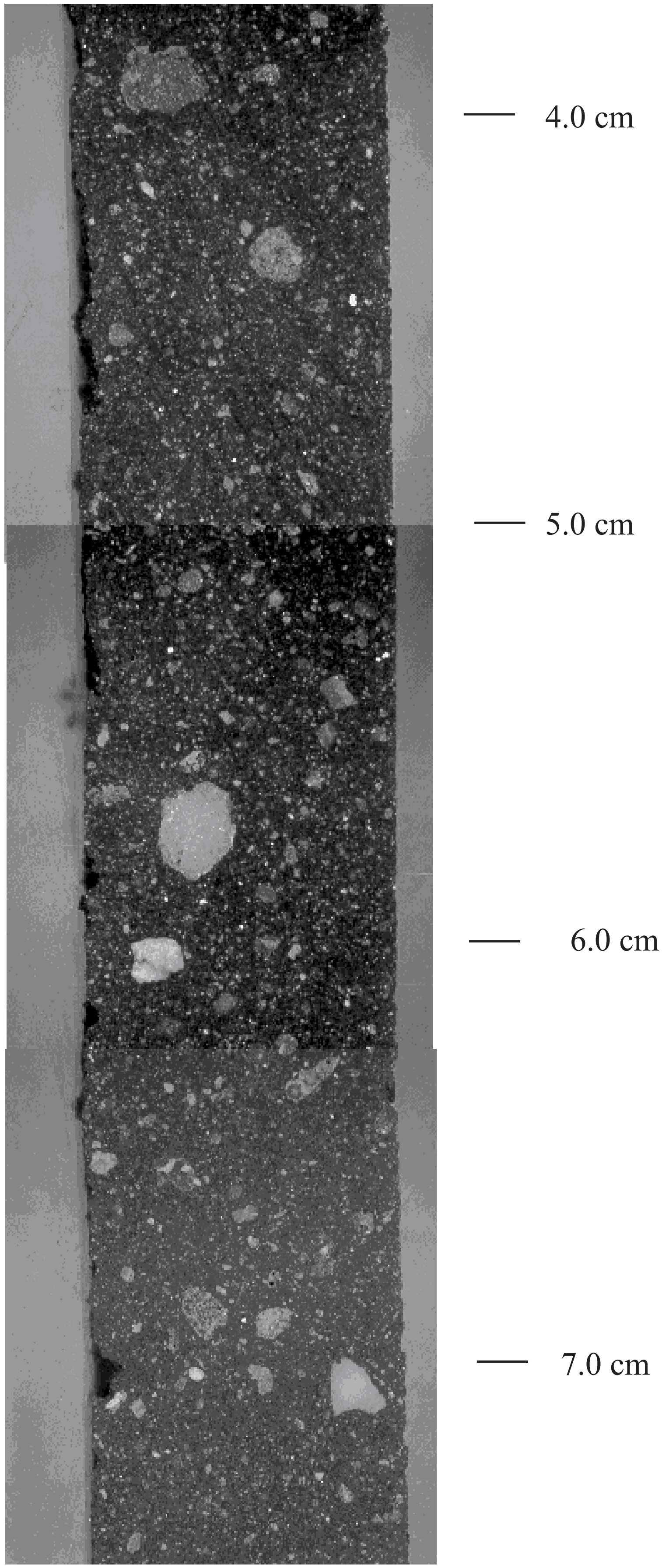
— 0.0 cm

76001,6011
epoxy
encapsulated
core

— 1.0 cm

— 2.0 cm

— 3.0 cm


4.0 cm
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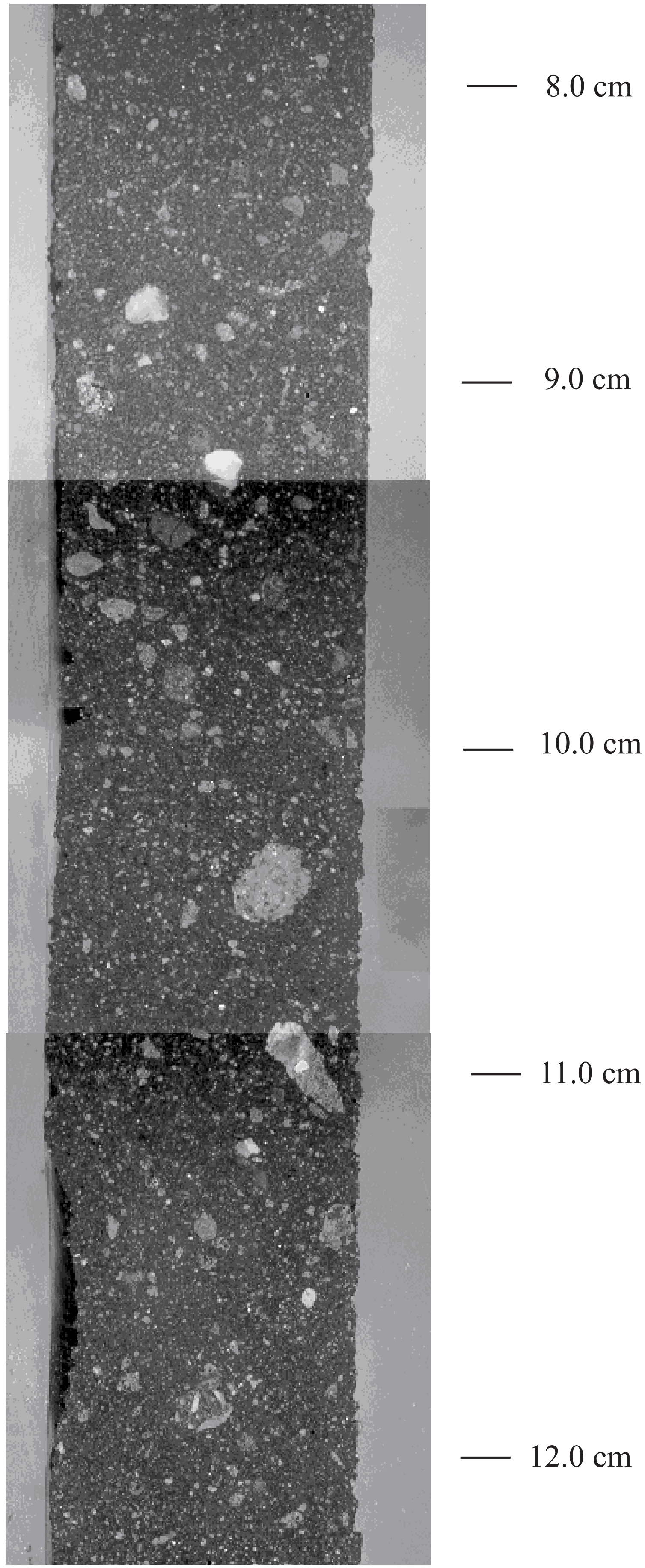
8.0 cm
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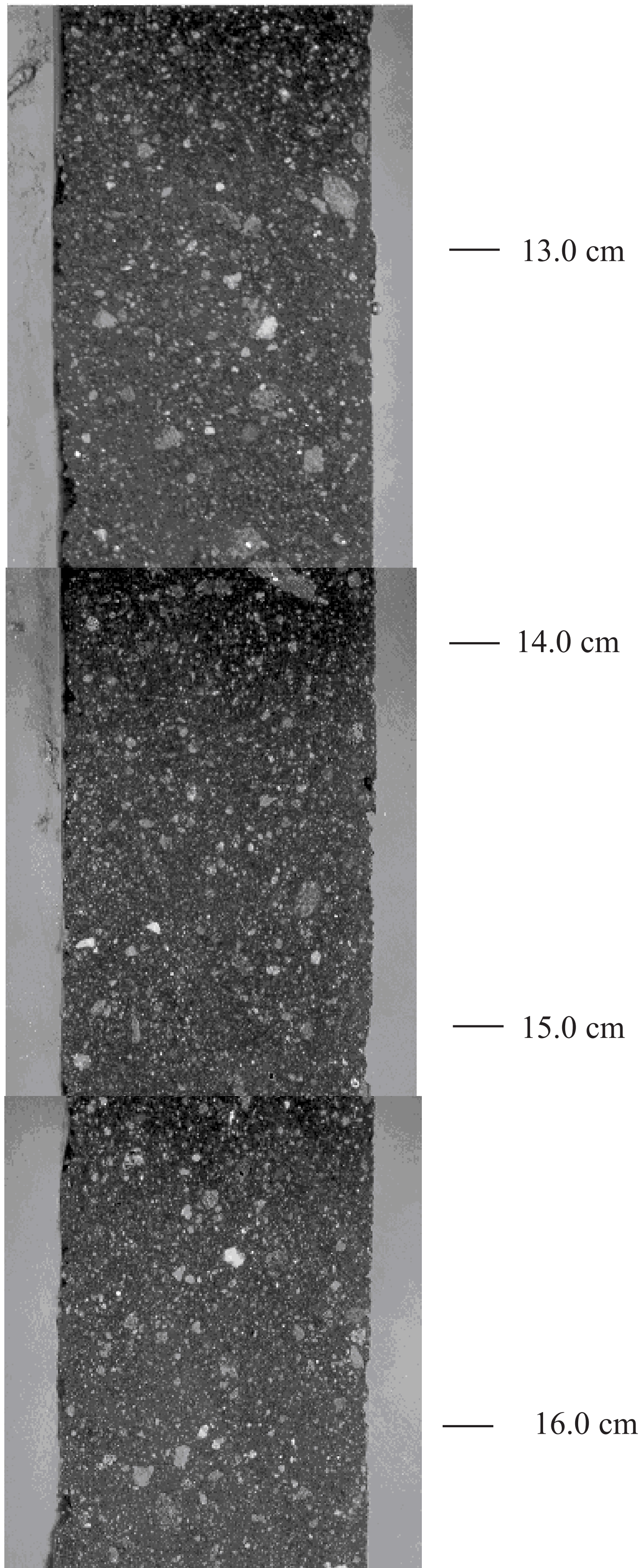
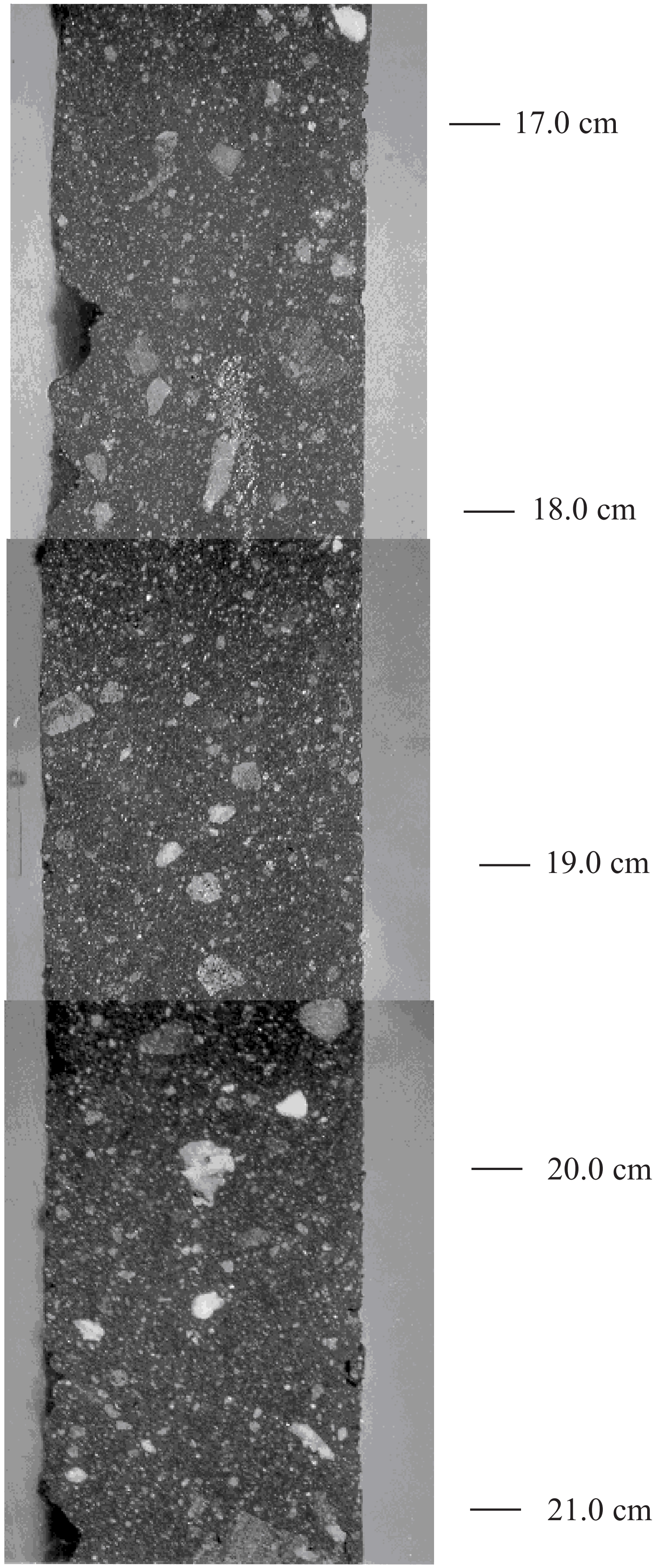
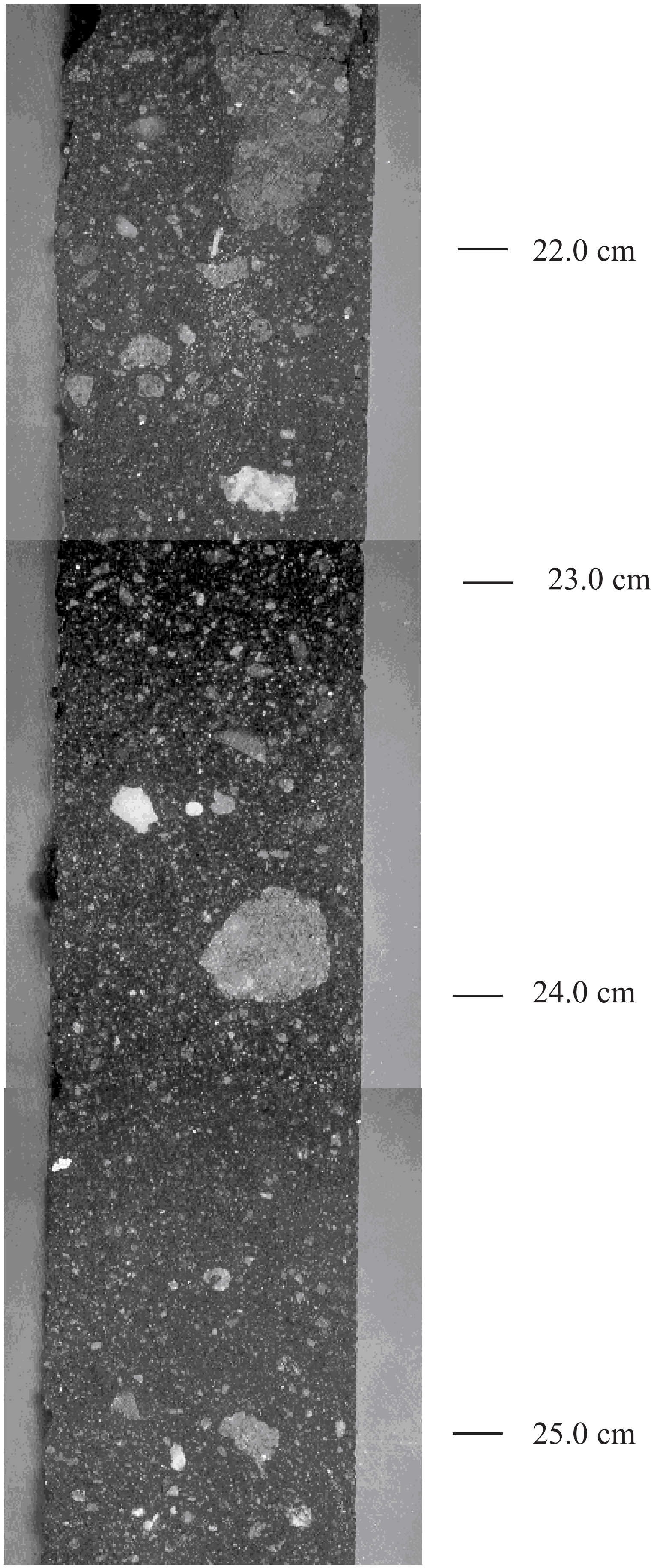
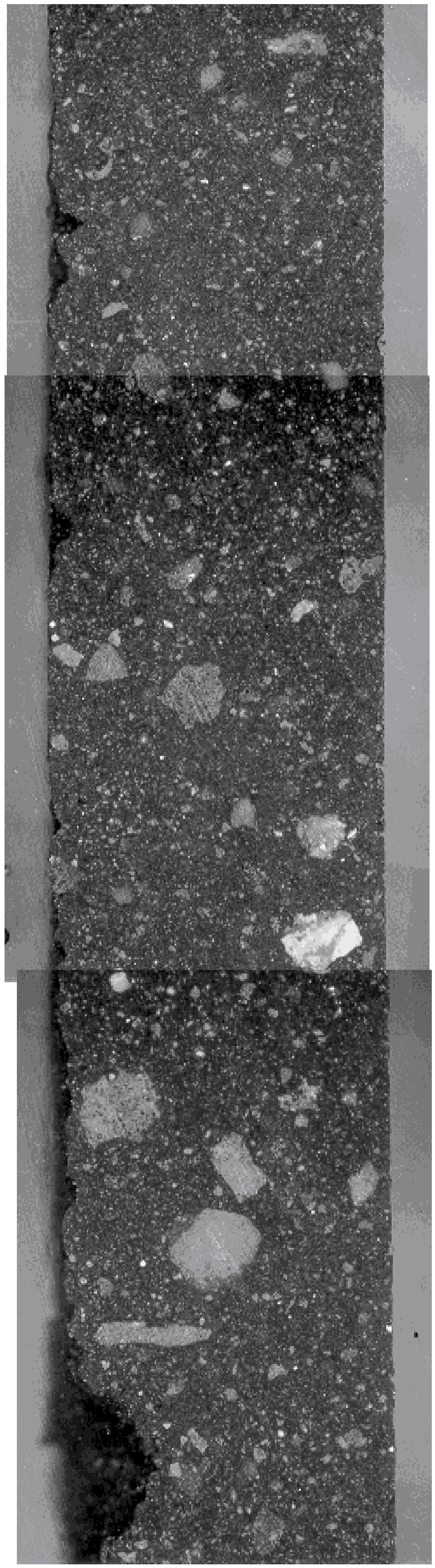
10.0 cm
11.0 cm
12.0 cm


13.0 cm
14.0 cm
15.0 cm
16.0 cm


17.0 cm
18.0 cm
19.0 cm
20.0 cm
21.0 cm



22.0 cm
23.0 cm
24.0 cm
25.0 cm

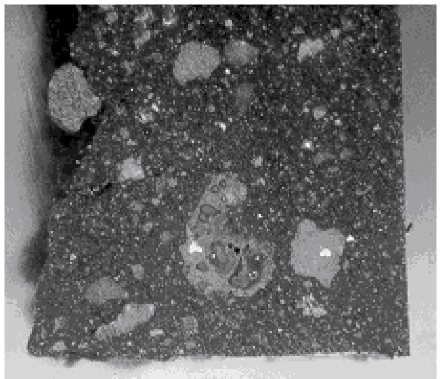


26.0 cm

27.0 cm

28.0 cm

29.0 cm



— 30.0 cm

— 30.6 cm

bottom of drive tube